CROW LANE LANDFILL
Newburyport, Massachusetts

Corrective Action Design (CAD)
Final Landfill Closure

Construction Quality Assurance Plan (CQA)
Final Closure Construction and Gas Extraction System Installation

October 2010 Submittal
Revised November 2010

Previous Submittals:
March 17, 2006
Revised: October 10, 2006
Revised October 24, 2006
Revised April 17, 2008

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1.0 INTRODUCTION

1.1 Objective

The objective of this document is to detail the procedures and testing requirements associated with the implementation of a Construction Quality Assurance (CQA) Program for the installation of the landfill final cover and landfill gas extraction systems on remaining uncapped portions of the Crow Lane Landfill. The program should serve as the basis for assessing construction procedures and the adequacy of soil material and geosynthetic material installations associated with the landfill capping system as well as the materials and installation of landfill gas extraction wells, lateral/header piping and all appurtenances thereto.

Because the final cover system is an important component of the landfill's environmental protection system, it is imperative that the cover be constructed in accordance with the approved plans and that a detailed record of the construction be produced to document that compliance.

This CQA manual satisfies the guidelines of the Department of Environmental Protection (DEP) as described in: Landfill Technical Guidance Manual (May 1997) and 310 CMR 19.106: Construction Certification.

1.2 Related Documents

Other documents related to this project include:

1. Technical Specifications, Prepared by SITEC Environmental, Inc., October 2010;
2. Project Design Drawings, prepared by SITEC Environmental, Inc.,

Crow Lane Landfill
Corrective Action Design
Final Landfill Closure Design

By SITEC Environmental, Inc.:

Dwg. 2	Existing Conditions and Collection System As-Built Plan, March 17, 2006, Latest Revision **11/8/10**;
Dwg. 3	Final Grading and Stormwater Management Plan, March 17, 2006, Latest Revision **11-8-10**;
Dwg. 4	Landfill Gas Management Plan, March 17, 2006, Latest Revision **10-20-10**;
Dwg. 4A	Gas Well Installation and Connection Plan Gas Extraction Wells EW-7, EW-10 and EW-13, October 1, 2007; Latest Revision **11/8/10**;

Dwg. 4B	Landfill Gas Treatment System Piping Diagram, March 1, 2007, Latest Revision **10-20-10.**
Dwg. 5	Landfill Cross-Sections and Perimeter Access Road/Berm Detail, March 17, 2006, Latest Revision **10-20-10;**
Dwg. 6	Final Cover System Details and Stormwater Management System Details 1, March 17, 2006, Latest Revision; **11/8/10**
Dwg. 7	Stormwater Management System Details 2, March 17, 2006, Latest Revision **11/8/10;**
Dwg. 8	Landfill Gas Management System Details, March 17, 2006, Latest Revision **11/8/10;**
Dwg. 9	Leachate Collection System As-built Details, March 17, 2006, Latest Revision **10-20-10;**
Dwg. 10	Final Capacity Plan, March 17, 2006, Latest Revision **10-20-10;**

By Cornerstone Environmental Group, LLC:

Dwg. No. 1	Gas Collection System-Site Plan, Dated: 10-5-06
Dwg. No. 2	Gas Details, Dated: 10-5-06

2.0 PROJECT MANAGEMENT

The following defines the responsibilities of the personnel involved with the implementation of the procedures outlined in this document and their respective duties during the construction project. The DEP will be informed of the assigned personnel prior to construction

A. OWNER. The Owner is the individual or designated representative of the firm, agency or municipality that owns and/or operates the facility.

The Owner and operator of this project is New Ventures Associates, LLC.

B. CONTRACTORS. The Contractors shall be responsible for acquiring and supplying all materials, labor, equipment and testing necessary for the proper completion of their specified work.

The Contractor will be selected at the discretion of the Owner.

C. ENGINEER OF RECORD. SITEC Environmental, Inc. is the "Engineer of Record" for the final closure of the landfill and has ultimate responsibility to certify project completion. The Engineer of Record will coordinate and supervise all construction CQA activities associated with both landfill final cover system and perimeter berm construction. The Engineer of Record will assign duties to qualified CQA personnel.

Should conditions be encountered during construction that requires modifications to any aspect of the design, the Engineer of Record shall be responsible for coordinating these changes and approvals, if necessary, with the MassDEP.

D. DESIGN ENGINEER. SITEC is the Design Engineer for final cap construction and well as stormwater management and landfill gas related systems. New Ventures has retained the services of McPhail Associates to provide geotechnical engineering services for a portion of the project that is limited to perimeter slope evaluations, surface treatment and construction. The Design Engineer (SITEC) is ultimately responsible for the implementation of the CQA program and the assignment of CQA activities. This includes providing technical support to the CQA Consultant, interpreting field and laboratory testing data, assuring construction activities are in accordance with design plans, attending meetings, making final determinations of the acceptability of installed work and in the preparation of the final certification report and endorsing the final certification report.

E. CQA CONSULTANT. The CQA Consultant must be knowledgeable and experienced in landfill final cover system construction projects. The CQA Consultant's field representative will serve as the daily contact person with the Contractors. The CQA Consultant is responsible for coordinating daily activities with the Contractors, maintaining field records, making judgments in conjunction with the Design Engineer on the acceptability of installed materials, maintaining construction summary reports as detailed in the Specifications and Drawings, and maintaining routine communications with the Design Engineer.

The CQA Consultant for this project is SITEC Environmental, Inc.

2.1 Project Organization

The following list of involved parties and contacts is provided for reference:

Function	Firm	Contact	Phone No.
Owner	New Ventures Associates, LLC	William Thibeault	(617) 387-1497
Engineer of Record/Design Engineer/CQA Consultant	SITEC Env., Inc.	Michael Quatromoni	(781) 319-0100
Earthwork Contractor	New Ventures	Ethan Owen	(617) 293-3681
Geomembrane Contractor	TBD	TBD	TBD
Gas System Well Contractor	Recovery Drilling	John Stone	(978) 355-5100
Gas System Piping Contractor	New Ventures Pipe Welding Subcontractor - TBD	Ethan Owen	(617) 293-3681

Function	Firm	Contact	Phone No.
Geomembrane Laboratory (Conformance Testing)	GeoTesting Express	Joe Tomei	(978) 635-0424
Geomembrane Laboratory (Destructive Testing)	GeoTesting Express	Joe Tomei	(978) 635-0424
Soils Laboratory	GeoTesting Express	Joe Tomei	(978) 635-0424
Regulatory Agency	Massachusetts DEP	Mr. David Adams	(978) 694-3295

3.0 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

3.1 General CQA/CQC Duties

Once installation begins, it is the CQA Consultant's responsibility to observe and document construction of the perimeter berm construction, final cover system installation and the installation of the gas extraction system components. In order to achieve this, the CQA Consultant must be at the site during critical phases of construction.

The CQA Consultant is responsible for observing the installation of the following components described in this section:

- Landfill Surface Preparation – This work includes all fine grading, filling, excavating and compaction necessary for the preparation of the landfill surface for the placement of the final cover system;
- Landfill Gas Extraction System - The landfill gas extraction system is comprised of the following three components:
  - The drilling and installation of vertical gas extraction wells in accordance with the Drawings prepared by SITEC Environmental, Inc. The work also includes header and lateral pipe including excavation, bedding and backfill of trenches, the installation of gas wellheads and appurtenances and connections to the existing system prior to commencement of final cover construction.
  - The installation of horizontal collection piping within Phase I and Phase II of the landfill in accordance with Drawings prepared by Cornerstone Environmental Group, LLC and;
  - The placement of geocomposite gas venting layer material directly on the prepared landfill surface prior to the geomembrane cap within Phase IA, Phase IIA and Phase III of the landfill. The work also includes the construction of horizontal gas collectors to be

installed in accordance with the Drawings prepared by SITEC Environmental, Inc. The horizontal gas collectors are designed for the purpose of drawing landfill gas collected within the geocomposite gas venting layer, if any, and conveying it to the gas treatment and flare unit.

- Geocomposite Gas Venting Layer – Upon completion of the landfill surface preparation and compaction and landfill gas extraction system installation, a geocomposite will be installed throughout the area to be capped. The geocomposite will have a high density polyethylene (HDPE) net core with 6 ounce non-woven geotextile fabric heat- bonded to each side. The ends and the side seams of geocomposite panels will be joined as specified and the terminal ends will be secured in anchor trenches.
- Geomembrane Cap - Textured Geomembrane Cap made of high-density polyethylene (HDPE), 40 mil thick, is to be placed in direct contact with the surface of the Geocomposite Gas Venting Layer. The Geomembrane materials shall be textured on both sides.
- Perimeter Embankments, Berms, Stone Buttress and Rip Rap Slope Treatment – Earthwork will be required around the northerly, southerly and westerly perimeter of the landfill in order to reduce the steepness of the existing slopes.

  Along the southerly side, an earthen berm will be constructed to the elevations and lengths shown on the drawings. The earthen berm will receive geotextile fabric lining and rip rap stone slope treatment for stabilization. This work will be conducted according the details presented on the drawings and technical specifications.

  The westerly slope embankment will include subgrade preparation and the placement of fill materials in order to reduce the steepness of the slope along this side of the landfill and to extend the slope upward to achieve appropriate elevations for final cap construction as presented on the site plan and details. The entire westerly slope embankment will also receive filter fabric and rip rap stone for slope stabilization in accordance with the details, specifications and section drawings. Subgrade preparation will include the removal of any organic soils or other unsuitable materials that may be encountered between the toe of the existing perimeter berm and the proposed outer limit of the extended slope. This removal includes those limited areas where there will be wetlands alteration as well as non-wetland locations around the westerly perimeter. This removal also includes excavation required to construct the 2.5 foot deep rip rap trench at the outer limit of the final rip rap slope as shown on the drawings. Refer to the detail drawing for the limits that unsuitable materials shall be removed and replaced. Areas that require unsuitable material removal shall be backfill and compacted with suitable backfill materials to appropriate grade and elevation.

Construction along the northerly side of the landfill will include embankment construction at 1.5:1 slope and the construction of a stone buttress for a limited length along the northerly slope. The limits of the stone buttress are shown on the site plan Drawing 3. A stone buttress detail is included on the detail drawing. Buttress construction will include the excavation of a four (4) minimum depth trench, the removal of any unsuitable organic materials and trench lining with geotextile fabric prior to stone placement. Buttress stone placement shall be according to the detail drawing. Suitable fill materials shall be placed and compacted to reduce the steepness of the slope throughout the northerly slope to 1.5:1. The final fill surface shall be lined with geotextilte filter fabrics in accordance with the details and specifications.

- Sand Drainage Layer - This layer will be placed above the Geomembrane Cap in a 12-inch thick layer and will be a granular sand having a minimum saturated hydraulic conductivity of 1×10^{-2} centimeters per second and a maximum particle size of 3/8 inch in its longest dimension.
- Topsoil Layer - This layer will be placed above the drainage/protection layer in an 8-inch thick layer and will be an organic loam (8%) free of large rocks, debris, stumps, and any other unsuitable matter, having the capacity to support vegetation. The vegetative support layer will have a maximum saturated hydraulic conductivity of 1.2×10^{-4} centimeters per second.
- Establishing vegetative cover – Applying a specified mixture of grass seed, lime and fertilizer to the completed landfill slopes and ensuring that a healthy growth of vegetation is established for the stabilization of the slopes.
- Installing erosion control blankets – Erosion control blankets of the types specified will be installed within the troughs and along the outside slopes of the stormwater diversion berms. The blankets will be secured in-place using staples as supplied by the manufacturer.

3.2 Gas Extraction System

The CQA Consultant will observe the construction of the landfill gas extraction system. Prior to gas extraction system construction, a Registered Land Surveyor shall layout the system according to the design drawings. It will be the responsibility of the CQA Consultant to approve the layout of the gas extraction system prior to the commencement of construction.

3.2.1 Vertical Gas Extraction Wells

Vertical gas extraction well installation will be logged and conditions encountered in the landfill will be recorded, included boring depth, material removed from borehole, liquid levels in the borehole, and presence of saturated material. Temperature measurements will also be monitored and recorded. Well installations will also be logged, including screen lengths, backfill materials,

well washers, bentonite plugs and well finishing details including well head assemblies as shown on the drawings. Trench excavations and installation of the horizontal headers and laterals will also be observed and recorded. The CQA consultant will ensure that as-built surveys are conducted for all piping installations and that proper slopes have been achieved for condensate management.

At this time, the all 16 vertical landfill gas extraction wells have been installed. These wells have been installed in accordance with the design drawings prepared by SITEC Environmental, Inc. and are shown on Drawing No. 4A included as part of the Corrective Action Design drawing set.

The piping to be used for header extension shall be SDR-17 high density polyethylene (HDPE) pipe. Segments of piping will be joined using the thermal butt-fusion welding technique as indicated in the Technical Specifications. New Ventures will retain the services of a qualified piping contractor to perform the welding and fabrication of the header piping string, along with the positioning of fitting along the header, in preparation for placement within prepared trenches. The installation of this type of piping, along with the requirement for butt-fusion welding, is limited to the extension of the header and the connections of lateral piping from the header to the extraction wells. A typical detail of the pipe and fittings configuration for the lateral connection to the header is shown on the Landfill Gas Management System Detail, Dwg. 8, prepared by SITEC Environmental, Inc.

3.2.2 Horizontal Gas Collectors

The CQA Consultant shall monitor the installation of the horizontal gas collector segments and associated appurtenances as construction progresses. Construction will not begin until the CQA Consultant has approved the products for use on the project. At a minimum during horizontal gas collector installation, the CQA Consultant shall be responsible to record and oversee the following:

- Approve the final layout of the horizontal gas collector segments and connector header piping as staked out by the Contractor's land surveyor; and
- Confirm and document all horizontal gas collector segments and header pipe trenches are excavated to the dimensions shown on the construction drawings; and
- Confirm that the excavated trench is lined with 4 ounce non-woven filter fabric with sufficient excess to overlap and extend beyond the sides of the trench;
- Confirm and document the thickness of pipe bedding material is installed at the bottom of excavated trench. The bedding material shall conform to project specifications and be a 3" sub-angular stone material; and

- Confirm horizontal gas collector and header piping is installed in trenches over trench bedding material. CQA Consultant shall ensure that care is used during installation so that the pipe is not damaged. The lengths of each pipe segment shall be recorded on a daily basis, including the different fittings installed (tees, valves, flanges, reducers, etc.). The CQA Consultant shall also confirm that sections of ADS slotted landfill gas collection pipe are coupled using 4" Fernco PN 1070 couplings or approved equal, as shown on the construction drawings and Confirm the remainder of trenches are backfilled with the necessary depth of 3" sub-angular stone;
- Confirm that as-built surveys are completed that document the locations of each collection pipe, valve, anchor trench, tees, wyes and fittings. These surveys should be completed prior to the installation of the geocomposite Gas Venting Layer.

3.3 Landfill Surface Preparation

The CQA Consultant will inspect the surface of the landfill prior to the placement of the geocomposite gas venting layer. Under no circumstances shall the geocomposite gas venting layer be placed on the landfill surface without following the specifications.

- The Contractor shall remove vegetation, roots, loam, organic matter, debris, solid waste and stones larger than 3-inches in size from the landfill surfaces. All observed objects that protrude more than one inch above the landfill surface shall be removed and replaced with granular fill material and compacted. The landfill surface shall be compacted to a smooth finish, free of ruts and surface irregularities. The CQA Consultant shall view the compaction efforts of the Contractor for all slope areas to be capped prior to the installation of the geocomposite gas venting layer. There should be no soft or yielding areas identified;

3.4 Geocomposite Gas Venting Layer

The Geocomposite Gas Venting Layer will be placed directly on the suitably prepared landfill surface. Before the Geocomposite Gas Venting Layer is installed, the CQA Consultant is responsible for:

- viewing the compaction efforts of the Contractor for all slope areas to be capped prior to installation. There should be no soft or yielding areas identified;
- ensuring that geocomposite testing have been performed at the proper frequencies and that the results are reviewed and approved by the Design Engineer; and
- ensuring that the gas extraction system has been installed according to the Design Plans and that all required as-built surveys have been completed.

3.4.1 Pre-Construction Testing

The Contractor shall submit quality control certificates provided by the manufacturer on each roll of Geocomposite to the Engineer. Test results must document compliance with the specifications of this Section.

The geocomposite shall be tested according to the test methods and frequencies listed below:

Ply Adhesion (ASTM D 7005)	50,000 SF	1 lb/in.
Transmissivity (ASTM D 4716)*	540,000 SF	1 x 10^{-4} m^2/sec.

* Geocomposite at gradient of 0.1, with a normal load of 10,000 psf between two steel plates.

As part of the Contractor's pre-construction testing, interface shear testing shall be performed on each interface of the cap system in accordance with ASTM D 5321 or ASTM D 6243 for those interfaces involving Geomembrane. Each test shall determine the interface shear strength at normal stresses of 1 psi, 2 psi and 4 psi. The geocomposite/geomembrane interface shall have a peak/post peak shear strength of $\geq 27^{\circ}$.

3.4.2 Material Placement

The geocomposite roll shall be secured within an anchor trench along the top of the slope and shall be installed lengthwise down the slope. The bottom of the last panel shall also be secured in an anchor trench to be excavate along the inside edge of the perimeter berm/access road. The anchor trenches shall be backfilled with granular soils that will not damage the geocomposite. The trenches shall then be compacted. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

On long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

In the presence of wind, all geocomposite shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until geomembrane installation necessitates their removal.

3.4.3 Seams and Overlaps

Each component of the geocomposite will be secured or seamed to the like component at overlaps.

Adjacent panels shall be secured by plastic ties (supplied by the manufacturer) approximately every five (5) feet along the roll length and by sewing the overlapped geotextile. Plastic ties shall be white or other highly visible bright colors for easy inspection. Metallic ties shall not be allowed. Sewing threads shall be of a color that provides contrast to the color of the geotextile.

Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.

The geonet portion should be tied every 6 inches in the anchor trench or as specified by the ENGINEER.

3.4.4 Repairs

Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with section 3.4.3.

3.5 Geomembrane Cap

3.5.1 Observation Requirements

The installation of the Geomembrane Cap will include the following related activities:

- delivery of geomembrane materials to the project site;
- final viewing of the geomembrane sub-grade/gas venting before placement of the geomembrane;
- delivery of geomembrane materials to the work area from the on-site storage area;
- deployment and positioning of geomembrane panels;
- geomembrane seaming and testing of seams;
- installing geomembrane boot seals at the gas extraction wells and at other locations where the gas piping is designed to penetrate the geomembrane cap;
- anchoring of geomembrane panels in an anchor trench; and
- placement of the sand drainage layer above the geomembrane.

Each of these activities must be observed and carefully documented by the CQA Consultant.

In addition to observation and documentation of geomembrane deployment, testing must be performed on samples of geomembrane to assure its conformance with project specifications. The results of Material Quality Assurance testing for each roll of geomembrane shall be supplied to the Design Engineer by the Geomembrane Contractor prior to deployment. The CQA Consultant will assure that only approved rolls are allowed for deployment.

Destructive and non-destructive testing must also be performed on seams constructed in the field. Destructive seam sample locations will be marked in the field by the CQA Consultant at a frequency of one sample location for every 500 feet of welded seam. The Contractor is responsible for extracting the samples for these conformance/acceptance tests as well as collecting seam samples for laboratory testing, observing testing of trial seams, and observing non-destructive testing of seams. The Owner reserves the right to collect additional samples for testing by the project's independent laboratory.

3.5.2 Materials Transport and Storage

The Geomembrane Contractor is responsible for the safe and proper transport of all lining materials to the project site. The only involvement of the CQA Consultant will be to ensure the scheduled arrival date of the geomembrane is acceptable to the Owner and to view the storage area before the material arrives at the site.

Once the geomembrane has arrived, the CQA Consultant will view all materials for visual evidence of damage and the conditions under which the geomembrane was transported to the project site. All observations must be documented and, if possible, should be performed in the presence of a representative of the manufacturer or Contractor. At a minimum the observations must include:

- Observing the unloading of the geomembrane at the designated on-site storage area. The storage area must be sufficiently distant from heavy equipment traffic and accessible only to authorized personnel.
- Recording the material quantities and geomembrane identification markings on each roll.
- The Design Engineer shall have the responsibility of conducting a completeness review of geomembrane manufacturer's Quality Control Certificates. Each roll must be accompanied by a certificate, which indicates the manufacturer's name, type of material, roll width and length, resin batch code and date of manufacture. *The manufacturer shall provide certification testing results, conducted at the frequency stated in the specifications, which include the material's thickness, density, melt flow index, carbon black content, carbon black dispersion, tensile properties, tear and puncture resistance.*
- The Design Engineer shall conduct a completeness review of raw material Quality Control Certificates. Since different geomembrane rolls for a specific project may be manufactured from different resin batches, a certificate must be furnished for each resin batch. The certificate should include a listing of the material's density, melt flow index, and carbon black content.

All information compiled must be entered into the project log and subsequently cross-checked with the project specifications.

In addition to viewing manufactured materials delivered to the project site, the CQA Consultant is responsible for viewing the material's storage area. The CQA Consultant should be thoroughly familiar with the manufacturer's storage specifications. Consideration should be given to ambient temperature, control of access, location with respect to vehicular traffic movements, and means proposed to protect the geomembrane from the elements. If the geomembrane is to be stored in contact with the ground, protective mats or sand may need to be spread on the surface to prevent damage from sharp rocks or debris. The surface of the storage area should be relatively level to prevent uncontrolled movement of geomembrane rolls.

3.5.3 Final Viewing of Geocomposite Gas Venting Layer

Before the Geomembrane Cap is delivered to the active construction area, a thorough viewing of the Geocomposite Gas Venting Layer must be completed. In order to minimize transport and exposure of the geomembrane to the elements, the Geocomposite Gas Venting Layer should be approved prior to allowing the Contractor to take rolls from storage.

Since the geomembrane is just one component of a multi-layered final cover system, it will be necessary to confirm that all appropriate CQA procedures for the Geocomposite Gas Venting Layer have been followed. The CQA Consultant will view the Geocomposite Gas Venting Layer surface before the geomembrane is brought to the active construction site and will obtain a geomembrane sub-grade acceptance form from the geomembrane Contractor.

3.5.4 Materials Delivery from On-Site Storage

Although the delivery of the geomembrane from storage to the active construction site may seem a simple task, its safe completion must be ensured. Every time a roll is handled or transported, the potential exists for damage. Therefore, caution must be exercised each time a roll is taken from storage.

Prior to the installation of geomembrane material, the Contractor must provide the CQA Consultant with a description of proposed transportation and handling procedures.

3.5.5 Geomembrane Placement and Positioning

Panel placement should commence at the upgradient limit of work and progress in a downhill fashion. The panels can be placed by manually unrolling the geomembrane into position or by using heavy equipment. The panels should be oriented parallel to the line of maximum slope,

(i.e., oriented up and down, not across, the slope). In corners and odd shaped geometric locations, the number of field seams should be minimized. No horizontal seams are permitted to be within five feet of the toe of the slope.
After the geomembrane is completely unrolled it must be positioned. If the panel is being installed abutting a previously placed panel, care must be taken to align the sheets for seaming. When positioned, wrinkles should be worked out of the geomembrane, prior to seaming.

All installed panels must be provided with ballast to prevent their movement in windy conditions. The Contractor shall provide ballast, as needed, to prevent the movement of deployed geomembrane. At a minimum, sand in burlap bags should be placed every 1 to 2 feet along a seam.

3.5.6 Geomembrane Seaming

Once adjoining panels are placed and aligned, seaming may commence. Two welding methods will be employed to seam the HDPE: (1) the double-track hot-wedge weld, and (2) the extrusion weld. Prior to completing either type of weld, the geomembrane surface to be welded must be generally free of dust, silt and debris. Furthermore, the welding surface must be dry and at the proper temperature. The Contractor should be equipped with an ample supply of clean rags to dry and remove dust from the welding surface. A means for preheating the seam prior to welding may be necessary in cold weather.

Cold Weather Seaming

Any cold weather seaming below 32° F must be performed in accordance with the guidelines prepared by the Geosynthetic Research Institute (GRI) entitled "GRI Test Method GM9, Standard Practice for Cold Weather Seaming for Geomembranes". A detailed protocol shall be submitted to the Owner for approval prior to performing cold weather seaming.

When the geomembrane sheet temperature is 32°F or less, the following additional requirements shall apply to seaming operations:

- Seams shall be pre-heated just ahead of the seaming operation. Shielding the geomembrane from the subgrade may be necessary, too.
- Trial welds should be performed more frequently as the length of time a seaming crew may work will likely be reduced.
- Trial welds shall be given additional scrutiny. It is particularly important, in cold weather, to make sure trial seams are made under the same conditions as will be experienced in the work-area. Since subgrade will be cold, the trial weld must simulate this condition.

- The CQA Consultant may require an increase in the frequency of destructive testing.

The lowest temperature at which seaming may take place shall be the lowest temperature at which consistent passing trial seams can be produced under simulated work-area conditions. No seaming will be conducted below 20° F. The CQA Consultant shall monitor temperatures during the installation process.

Hot Weather Seaming

Seaming in hot weather will likely be controlled by the ability of the seaming crew to work under such conditions. Also, during high temperature conditions seam "burn-outs" can occur. If an excessive number of "burn-outs" occur, seaming operations should cease. The effects of high temperatures on seaming may be counter-acted by increasing the speed of seaming or decreasing the welding temperature. However, this may affect seam strength so seam quality should be checked via trial welds and/or additional destructive tests.

Hot-Wedge Weld

The hot-wedge weld is accomplished using a special device to heat adjoining geomembrane panels. The welding device is equipped with a heating element, referred to as the hot-wedge, which is allowed to contact the bottom of the overlapping panel and the top of the previously placed panel. Once the adjoining panels are overlapped a minimum of four inches and heated via the hot-wedge, the two surfaces are squeezed together with rollers resulting in a bond between the adjoining panels. Since the hot-wedge welding machine is equipped with two wedges and two sets of rollers, the final bond actually consists of parallel welds with an air gap between the welds. The hot-wedge welding method is dependent on the temperature of the hot-wedge and the speed at which the welding is performed. Both of these variables are controlled by the machine operator.

Extrusion Weld

Extrusion welding joins abutting geomembrane panels by creating a bond between the panels with an extruded bead of high-density polyethylene. This welding process requires additional preparation above and beyond usual cleaning of the weld surface. Specifically, the weld surface must be abraded to remove the sheen on the surface of the geomembrane and to provide a surface which is more conducive to accepting a weld. Abrasion of the weld surface is normally accomplished using a disc grinder with an abrasive disc. Great care must be taken to assure that the abrasion process does not sacrifice the strength of the weld by substantially diminishing the thickness of the geomembrane. Testing of an extruded weld seam is performed using a vacuum box.

General Seaming Requirements

Regardless of the seaming procedure employed by the Contractor, the following general requirements must be satisfied during the seaming of the geomembrane.

- Seaming shall only be performed under proper weather conditions. The highest and lowest allowable temperatures for welding is based on conditions such as ambient temperature, wind, subgrade conditions, exposure to sunlight, material type, and material thickness. Welding in such temperatures can be performed by increasing or decreasing the welding speeds and/or hot-wedge temperature. Seaming shall be performed when the geomembrane is dry and protected from any wind damage. The CQA Consultant shall determine whether or not the weather conditions are appropriate. An ambient temperature between 32°F and 122°F as measured six inches above the geomembrane surface is recommended.
- All seams must extend the full length of the panels being joined. When seaming adjacent panels along an anchor trench, the seam shall extend completely through the anchor trench.
- All "fish-mouths" and wrinkles on a seam must be removed by cutting the geomembrane and installing an overlapping patch.
- Every seam, once completed, must be tested by non-destructive testing procedures to check its continuity. Seams, which do not pass such testing, must be repaired and retested.
- Seam samples for destructive testing must be taken at a minimum of one every 500 feet. The sample location shall be randomly selected by the CQA Consultant. Additional testing may be warranted when seaming conditions are not optimal due to ambient temperature or if there is reason to suspect that the seam quality is inadequate.
- The Contractor is responsible for the collection of seam samples. Duplicate samples shall be provided to the CQA Consultant for testing by an independent laboratory.

3.5.7 Conformance/Acceptance Testing

Geomembrane Resin

The manufacturer of the geomembrane shall supply the CQA Consultant with quality control certificates on each batch of resin used to produce geomembrane and welding rod for the project. The certificates shall be prepared by the resin producer and provide results of tests indicated in the table below:

GEOMEMBRANE RESIN CONFORMANCE TESTS			
Material	**Test**	**Standard**	**HDPE Value**
HDPE	Density	ASTM D1505A	0.930 g/cc (min.)
	Melt Flow Index	ASTM D1238E	0.4 g/10 minutes (max.)
	Carbon Black Content	ASTM D4218	2%-3%

Geomembrane Rolls

Each roll of geomembrane material supplied by the manufacturer shall be accompanied with a quality control certificate that indicates the information listed below. The data on the certificates will be compared with the project specifications.

Thickness:	36 mils (min.)
Density:	0.94 g/cc (min.)
Melt Flow Index:	0.4 g/10 minutes (max.)
Carbon Black Content:	2%-3%
Carbon Black Dispersion:	Category 1 or 2
Tensile Properties:	-
- Strength @ Yield:	84 ppi
- Strength @ Break:	60 ppi
- Elongation @ Yield:	13%
- Elongation @ Break:	150%
Tear Resistance:	28 lbs.
Puncture Resistance:	72 lbs.

Interface Shear Testing

Interface shearing testing will be performed on each interface of the final cover system in accordance with ASTM D5321. This testing shall be performed by the Earthwork Contractor. Normal stresses applied to each test will be 1 psi, 2 psi and 4 psi. The following interfaces must be evaluated:

- Interface shear tests shall be performed between the geomembrane and the geocomposite gas venting layer and between the geomembrane and the sand drainage layer interfaces in accordance with ASTM D5321. The interface friction angle between the geomembrane and the geocomposite gas venting layer and the geomembrane and the sand drainage layer soil shall be a minimum of 27°.
- 40 mil. Textured HDPE Geomembrane/Sand Drainage Layer - the interface shear test shall be conducted at approximately 87.5 percent of the maximum dry density of the drainage layer material under saturated conditions.

3.5.8 Construction Testing

Trial Seams

Trial welds shall be performed with each welding apparatus to be used as follows:

- At the beginning of each seaming period;
- At least once every four (4) hours;
- When the person running the welding equipment has changed;
- When the welding equipment has been shut-off or has been unused for a period for one hour or longer; and
- If there has been a 20°F rise or drop in ambient temperature since the last passing trial weld.

The frequency of trial welds may need to be increased under cold weather and hot weather conditions.

Trial welds shall be performed by the welder responsible for using that piece of equipment. The objective of the trial weld is to simulate field seaming conditions. No attempt should be made to create an "ideal" environment for completing a trial weld.

A trial weld shall be performed on fragment pieces of geomembrane; a minimum of 3-feet long for extrusion welded trail seams and a minimum of 10-feet long for fusion welded seams. Once completed, the weld shall be visually inspected for deficiencies before taking a minimum of seven, one-inch wide random samples from the trial weld. The seven specimens shall be tested by the Contractor for peel and shear strength (five in peel, two in shear) using a field tensiometer with the results being recorded. When peel testing is performed, both welds of double fusion welds should be tested to provide an indication of the quality of the weld. Only those pieces of equipment which provide passing test results may be used for seaming or repair work. All trial weld specimens should exhibit a film tear bond (FTB) and meet or exceed the minimum seam strength requirements as shown in the table below.

FIELD SEAM STRENGTH REQUIREMENTS		
40-Mil Textured HDPE	**Hot-Wedge Weld**	**Extrusion Weld**
Peel Strength	70% of GSYS	60% of GSYS
Peel Separation	10%	10%
Shear Strength	90% of GSYS	90% of GSYS

GSYS: Geomembrane Specified Yield Strength

Additional trial welds must be performed for failed samples. This retesting procedure should include adjusting the temperature of the hot-wedge (or extrusion welding gun) and/or the speed at which the hot-wedge weld is performing. Once adjustments have been made, additional trial welds are made on fragments of geomembrane which eventually will be retested. If the specimen fails, the seaming apparatus and procedures will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved.

The CQA Consultant will:

- observe and document the trial welds;
- confirm trial weld samples are properly labeled (e.g., machine number, welder, temperature control setting, and test results); and
- archive trial welds for the Owner.

Non-Destructive Testing

The purpose of non-destructive seam testing is to verify the continuity of a field seam, not to provide an indication of the seam's strength. All seams constructed in the field shall be subjected to non-destructive testing along their entire lengths. The CQA Consultant will observe the tests, record test results, the name of the individual performing the test, and the location of the test. Areas found to be defective shall be marked as requiring repair. In general, seam testing should be done concurrently with seaming operations. The Contractor should not be permitted to complete all field seams prior to the commencement of testing.

Non-destructive seam tests should be completed using the Air Pressure Test or the Vacuum Box Test as outlined in this section, unless otherwise approved by the Design Engineer.

Air Pressure Test

The air pressure test will be performed on all double-track hot-wedge welds. This test method involves the application of air pressure to the channel between the parallel welds for a specified period of time and observing the stability of the pressure for the duration of the test.
The usual procedure for completing an air pressure test is as follows:

- Seal both ends of the seam length to be tested.
- Insert air feed device (usually a hollow needle) into the air channel between the two parallel welds.

- Pressurize the air channel to a pressure between 30 and 35 psi, then cease air flow to the seam by closing the valve in air feed line.
- Once pressurized, the seam should be allowed to stand for a two minute "relaxing period." This period will allow the air temperature and pressure in the seam channel to stabilize.
- Record seam pressure at the end of the "relaxing period" and use the recorded pressure as the "initial pressure" for the seam test. If the "initial pressure" is below 30 psi, additional air shall be introduced into the seam channel so that a minimum pressure of 30 psi is used to start the test.
- Allow seam channel to stand for 5 minutes. If a pressure loss exceeds 3 psi, the seam shall be considered discontinuous and repairs will have to be made.
- At the conclusion of a passing seam channel test, the end of the seam channel opposite the pressure test gauge must be cut to relieve the test pressure. If the pressure gauge does not detect a drop in pressure it must be assumed that the seam channel is blocked. In this case the location of the blockage must be identified and the seam retested in segments for continuity.

Following the seam test the CQA Consultant will verify that seam channel perforations and cuts made during the test have been properly sealed. Any defective areas shall be marked, repaired, and retested by the Contractor using the vacuum box test method, as detailed in the next section.

AIR PRESSURE TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
HDPE	Seam Continuity	Air Pressure Test	100% of Double Fusion Weld Seams

Vacuum Box Test

The vacuum box test is typically used on seams which cannot be tested by air pressurization. This test is predominantly used on extruded welds for patches and repairs.

The procedure for completing a vacuum box test is as follows:

- Apply a generous amount of soapy solution to the seam length to be tested.
- Place vacuum box test apparatus over wetted portion of the seam and apply a vacuum of at least 8 inches of mercury (4 psi) to the seam.

- Allow test apparatus to stand at the applied vacuum for a period not less than 10 seconds. During the test, the response of the soapy solution should be observed and noted. Bubbling of the solution indicates the presence of a hole or discontinuity, of which the location shall be marked and repaired.
- Move the vacuum box over to adjoining areas with a minimum three inches overlap, and repeat the process.

Since the test apparatus must be moved along the length of the seam in order to perform a complete seam continuity test, the CQA Consultant must confirm segments of the seam are not passed over and that the test is conducted for the appropriate duration.

VACUUM BOX TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
HDPE	Seam Continuity	Vacuum Box Test	100% of Extruded Weld Seams

Destructive Testing

The non-destructive seam testing procedures only establish seam continuity and not seam strength, it does not provide for a quantitative comparison with specified seam qualities. As a result, samples of completed seams must be collected and subjected to laboratory examination. At a minimum, one seam sample must be taken, at random, every 500 feet of seam length. If field conditions warrant, or the CQA Consultant suspects a seam may not have been constructed properly, samples may be collected at a greater frequency.

Sample Collection

One seam sample shall be collected, at random, a minimum of every 500 feet of seam. Each sample shall be cut from the seam by the Contractor. The CQA Consultant will:

- Specify locations for the test samples.
- Observe the collection of samples.
- Identify the sample with a number and verify it is marked accordingly.
- Note the sample location, the date, the reason for sampling (e.g., random sample, previous failure), and other pertinent information in the project log.
- Confirm that the sample location is repaired as soon as practicable following sample collection.

Sample Size & Failure Response

Destructive samples shall be at least twelve (12) inches wide, centered over the seam, and forty-eight (48) inches long, along the seam. Seven 1-inch wide by 12-inch long strips shall be cut from each sample (three from one end and four from the other end). Each strip shall be tested by the Contractor for peel and shear strength (five in peel, two in shear) using a field tensiometer. When peel tests are performed, both welds of double fusion welds should be tested to provide an indication of the quality of the weld. All specimens should exhibit a film tear bond and meet or exceed the minimum seam strength requirements as shown above. If the sample passes the field peel and shear tests, the remaining sections are cut and distributed as follows:

- one 12 inch by 12 inch section for the Owner's archives;
- one 12 inch by 12 inch section for shear and peel testing by the Contractor; and
- one 12 inch by 15 inch section for shear and peel testing by an independent laboratory.

If the sample fails the field peel and shear tests by the Contractor or that of the independent laboratory, then the Contractor has the following options:

- Reconstruction of the seam between the failed location and any passed test section, which includes cap stripping of the seam, replacing the failed seam with a new one foot wide panel which is welded over the seam or extrusion welding of the failed seam; or
- Retrace the failed seam in both directions, by taking additional destructive samples and conducting field peel and shear tests, until the length of the poor quality seam is established. Additional destructive samples should be collected at minimum intervals of ten (10) feet from the location of the failed sample. Upon attaining passing results from the destructive samples, the seam shall be reconstructed between the passing location and the original failed location.

All passing seams must be bounded by two locations from which passing laboratory destructive tests have been taken. Large reconstructed seams, over 50 feet or more in length, are under the same requirements as smaller failed seams in which a sample must be taken from the reconstructed seam in order to pass the destructive testing.

Laboratory Testing

An independent testing laboratory will be perform all material conformance testing and confirmation of the field destructive seam testing. Samples should be collected, packaged, and sent to the testing laboratory, on the same day that the samples are obtained.

All independent laboratory testing shall be in accordance with the requirements of this specification. Conformance testing shall conform to the standards listed and destructive seam samples will be tested for peel and seam strength, and shear elongation. For each destructive sample submitted, five (5) specimens shall be tested under each test method. When peel testing is performed, both welds of double fusion welds should be tested to provide an indication of the quality of the weld. In order for the sample to pass, four (4) of the five (5) specimens must meet the minimum test values presented in the project specifications and exhibit a film tear bond. Also, the failing specimen must be at least eighty percent (80%) of the minimum seam strength requirement. Laboratory results shall become available in a timely manner so as to allow the Design Engineer or CQA Consultant time to notify the Contractor of any failures. No areas of the geomembrane may be covered prior to receiving test results from the independent laboratory.

DESTRUCTIVE TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
HDPE	Seam Peel *	NSF 54/ASTM D4437	1 Test/500 LF
	Seam Shear	NSF 54/ASTM D4437	1 Test/500 LF

* Both welds shall be tested on samples of double-track welds.

3.5.9 Detail and Repair Work

Once the geomembrane has been deployed, the panels must be examined for flaws, holes, defects and tears. Each location shall be repaired using the following procedures:

- Patching - A patch is used to repair defects in the geomembrane which are larger than 1/8-inch.
- Abrading and Re-welding - This procedure is used to repair small seam sections.
- Spot Welding - Spot welding is used to repair small tears, pinholes and/or other small defects.
- Capping - Used to repair large lengths of failed seams.

Patches or caps shall extend at least six inches beyond the edge of the defect. Edges of the patch or cap shall be extrusion welded to the existing geomembrane after a disc grinder with an abrasive disc has abraded the geomembranes. This procedure is done to remove the sheen of the surface of the geomembrane and to provide a surface that is more conducive to accepting the weld. Welding of the repair patch is completed by extrusion welding the geomembrane. The repairs shall be non-destructive tested using the vacuum-box method as described in this Section.

3.6. Sand Drainage Layer

3.6.1 Observation Requirements

The sand drainage layer includes a network of perforated subdrains placed on the surface of the geomembrane and covered by a permeable drainage layer. The sand drainage layer materials are used to convey water from the surface of the Geomembrane Cap into the run-off control system where it can be properly managed. Before the sand drainage layer is installed, the CQA Consultant will:

- view the Geomembrane Cap prior to the installation of the sand drainage layer;
- view incoming loads of the sand drainage layer material; and
- ensure that geomembrane testing and sand drainage layer soil testing has been performed and results reviewed by the Design Engineer.

During installation of drainage layer, the CQA Consultant will:

- observe the placement of the sand drainage layer material on the surface of the geomembrane; and
- confirm that the thickness of the sand drainage layer conforms with the project specifications. This will be accomplished through the digging of small observation holes with a spade or shovel and making required measurements. This will be performed at a minimum frequency of five (5) observation holes per acre. Additional depth verification will be conducted if determined necessary by the CQA Technician to ensure a uniform thickness of the sand layer.

3.6.2 Pre-Construction Testing

Prior to any construction, the Contractor shall submit results of pre-construction testing conducted on representative samples of the Contractor's source of sand drainage layer material. In addition, the Contractor must submit results for geomembrane interface friction testing in accordance with the table below. The CQA Consultant will review all test results with the Design Engineer.

The Contractor must also submit representative samples of the sand drainage layer material for independent pre-construction testing by the Owner or CQA Consultant.

SAND DRAINAGE SOIL PRE-CONSTRUCTION TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
Sand Drainage Layer Soil	Grain Size	ASTM D-422	1 Test/Each Source
	Permeability	ASTM D-2434	1 Test/Each Source

SAND DRAINAGE SOIL PRE-CONSTRUCTION TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
	Interface Shear w/ Geomembrane	ASTM D-5321	1 Test/Each Source
	Direct Shear	ASTM D-3080	1 Test/Each Source

Interface shear and direct shear testing shall be performed at Normal stresses of 1 psi, 2 psi and 4 psi.

Refer to Section 3.5.7 of this CQA Plan and the applicable sections of the Technical Specifications for interface/internal shear testing as well as permeability and grain size requirements for the sand drainage layer materials.

3.6.3 Construction Testing

The Design Engineer and CQA Consultant must confirm that the necessary grain size and hydraulic conductivity tests have been performed. The Contractor is responsible for taking one sample of the sand drainage layer material during placement every 1,500 cubic yards (see table below). The Contractor will be responsible for collecting, packaging, and sending all samples to the laboratory.

The Owner and CQA Consultant reserve the right to collect additional samples for testing by the project's independent laboratory.

SAND DRAINAGE SOIL CONSTRUCTION TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
Sand Drainage Layer Soil	Grain Size	ASTM D-422	1 Test/1,500 CY
	Permeability	ASTM D-2434	1 Test/3,000 CY

3.7 Topsoil Layer

3.7.1 Observation Requirements

The topsoil layer material is used as the top layer in a final cover system and will be soil capable of providing the proper base for establishing surficial grasses for erosion control. Before the topsoil layer is installed, the CQA Consultant will:

- view the sand drainage layer prior to the installation of the topsoil layer;
- view incoming loads of the topsoil layer material; and
- ensure that sand drainage layer testing has been performed and results reviewed by the Design Engineer.

During installation of topsoil layer, the CQA Consultant will:

- observe the placement of the topsoil layer material over the sand drainage layer; and
- confirm that the thickness of the topsoil layer conforms with the project specifications. This will be accomplished through the digging of small observation holes with a spade or shovel and making required measurements. This will be performed at a minimum frequency of five (5) observation holes per acre. Additional depth verification will be performed as determined necessary by the CQA Technician to ensure a uniform thickness of the topsoil layer.
- Should the Contractor utilize a blended topsoil material produced through the mixing of base soil with compost material, the CQA Consultant shall conduct visual examinations of the finish product. The CQA Consultant shall examine the material to ensure that it is a homogeneous blend of soil/compost and that it remains consistent with the representative samples submitted for laboratory testing according to the specifications.

3.7.2 Pre-Construction Testing

Prior to any construction, the Contractor shall submit results of pre-construction testing conducted on representative samples of the Contractor's off-site source of topsoil layer material. Should the Contractor produce a blended topsoil material using composted materials, pre-construction testing shall be performed and submitted by the Contractor on the finished product. The CQA Consultant will review all test results with the Design Engineer.

The Contractor must also submit representative samples of the topsoil layer material for independent pre-construction testing by the Owner or CQA Consultant.

TOPSOIL MATERIAL PRE-CONSTRUCTION TESTING			
Material	**Test**	**Standard**	**Min. Test Frequency**
Topsoil Material	Grain Size	ASTM D-422	1 Test/Each Source
	pH	ASTM D-4972	1 Test/Each Source
	Organic Content	ASTM D-2974	1 Test/Each Source
	Permeability	ASTM D-2434	1 Test/each source

3.7.3 Construction Testing

The Contractor is responsible for taking one sample of the topsoil layer material during placement every 1,000 cubic yards (see table below). The Contractor will be responsible for collecting, packaging, and sending all samples to the laboratory.

The Owner and CQA Consultant reserve the right to collect additional samples for testing by the project's independent laboratory.

TOPSOIL MATERIAL CONSTRUCTION TESTING			
Material	Test	Standard	Min. Test Frequency
Topsoil Material	Grain Size	ASTM D-422	1 Test/1,000 CY
	pH	ASTM D-4972	1 Test/1,000 CY
	Organic Content	ASTM D-2974	1 Test/1,000 CY

3.7.4 Seeding Requirements

The CQA Consultant observes the Contractor's operations regarding the application lime, fertilizer and seed and shall verify compliance with the specified mixtures and application rates.

3.8 Storm Water Controls

3.8.1 Observation Requirements

Storm water controls such as run-off diversion berms, swales, channels and storm water basins will be installed to control run-off from the final cover system. The Contractor will confirm the location and grades of the structures, along with confirming that materials conform with the project specifications and the design drawings.

3.8.2 Geomembrane Channel Lining

The perimeter draingage channels to be constructed along portions of the northerly and easterly perimeter berm shall be lined with geomembrane in order to prevent stormwater flowing within the channel from penetrating the perimeter berm materials. The limits of the drainage channel to be lined are presented on Drawing 3 and details of the installation are included on the detail sheet. The installation of the geomembrane flap beneath the drainage channel shall also accomplish the repair of damaged geomembrane along the base of the perimeter berm. The geomembrane sheets shall be extended up the landfill slope to cover all damaged geomembrane. The distance required to cover damaged areas is variable and will be subject to in the field determinations by the CQA Consultant. Once the channel if formed and lined with membrane, a geotextile fabric shall be applied followed by base materials comprised of asphalt grindings followed by a second layer of fabric and then the placement of rip rap channel lining stone. The installation of geomembrane lining shall also extend through the riprap lined apron that provides for the discharge of the drainage channels to Stormwater Basin No. 2 as shown on the drawings.

4.0 DOCUMENTATION AND RECORD-KEEPING

The effectiveness of a CQA plan is largely dependent on the ability to properly monitor and document all activities. It is the responsibility of the CQA Consultant to observe and document the activities of the Contractors in sufficient detail and with sufficient continuity to provide a high level of confidence that the work product complies with the design drawings and specifications. Documentation to be provided by the CQA Consultant shall include daily work summaries of construction activities, all laboratory test results, design and specification revisions and construction photographs. The CQA Consultant shall maintain at the site a complete file of plans and specifications, a CQA manual, test procedures, daily reports, and other pertinent documents.

4.1 Daily Record-keeping

The CQA Consultant will compile daily logs which detail the construction activities, observation and testing data sheets, meetings and/or discussions, the names of site visitors, and any construction problems along with the actions taken to alleviate the problem. Examples of CQA record keeping forms are provided in Appendix A.

4.2 Observation and Testing Reports

The CQA Consultant will compile and maintain a complete record of material test results. All applicable test results will be included in the certification report.

4.3 Changes to Specifications/Drawings

In the event that any design and/or specification changes are required, the CQA Consultant shall notify the Design Engineer. Design and/or specification changes shall be made only with the agreement of the Design Engineer and shall take the form of an addendum to the specifications or design drawings.

4.4 Photographic Documentation

The CQA Consultant will maintain a detailed photographic record of the construction activities to provide a pictorial record of the progress of work, any problems which arise, and the mitigation activities related to those problems. The photographic record will be included in the certification report.

4.5 Deficiencies/Corrective Measures Reports

In the event that problems or work deficiencies arise, the CQA Consultant should determine the nature and extent of the deficiency, notify the Contractors, and properly document the situation.

The procedure for handling such a situation is to define and discuss the problem/deficiency, review any alternative solutions, and implement a plan to resolve the problem/deficiency. In the event the issue is not resolved, the CQA Consultant shall notify the Design Engineer. All discussions and meetings related to the problem/deficiency shall be documented by the CQA Consultant. A corrective measures report shall be prepared, if necessary, and should include the location, description, and probable cause of the problem, along with any recommended corrective measures to ensure that the problem/deficiency does not occur again.

4.6 Record Drawings

Once the project has been completed, record drawings will be prepared by the Design Engineer to document the as-built conditions of the site. The record drawings will present the limits and elevations of the final cover system, drainage features, landfill gas system components and other relevant features of the final closure. The Record Drawings will also show the locations of geomembrane panels, field seams, destructive tests, and repairs.

4.7 Final Report

After completion of the construction work, the CQA Consultant and Design Engineer will prepare a final certification report in accordance with 310 CMR 19.106. The purpose of this report is to certify that the work has been performed in compliance with the approved plans and specifications, and include supporting documentation. The report must include a summary of all construction activities, observations and test results, construction problems and their solutions, changes in design and/or material specifications, photographs of the construction activities, record drawings, and any other pertinent information.

5.0 MEETINGS

5.1 Pre-Construction Meetings

A pre-construction meeting should be held before any construction activity commences. This meeting should be attended by the Owner, the Design Engineer, the CQA Consultant, and the Contractors. The intention of this meeting will be to review the design plans and specifications, appoint each party's responsibility, and to discuss any problems which may arise during construction.

5.2 Progress Meetings

Progress meetings should be held on a routine basis. These meetings may be necessary in order to solve problems, improve lines of communication and discuss the status of the project to date.

5.3 Final Viewing of Work

At the completion of the project, a final viewing of the work should be performed. The Owner, the Design Engineer and CQA Consultant should walk the site to view the construction.

END

APPENDIX A

Sample CQA Record Keeping Forms

SITEC
ENVIRONMENTAL
Hazardous and Solid Waste Consultants
New Bedford • Marshfield

Phone: (508) 998-2125 • (781) 319-0100
Fax: (508) 998-7554 • (781) 834-4783
Internet: www.sitec-engineering.com

DAILY CONSTRUCTION FIELD REPORT

Date:
Project No.:
Project:
Location:
Client:
General Contractors:
Sub-Contractor:

GENERAL INFORMATION

SITEC Personnel Present:	*Arrival Time:* *Departure Time:*
Contractor Personnel Present:	*Equipment Used:*
Weather: *Temperature:*	*Comments:*

SERVICES PERFORMED & OBSERVATIONS:

_____ _____ *Title:* _____

Date *SITEC On-Site Supervisor*

Copies to: _____ *Report No.* _____

SITEC
ENVIRONMENTAL
Hazardous and Solid Waste Consultants
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Phone: (508) 998-2125 • (781) 319-0100
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Internet: www.sitec-engineering.com

GEOMEMBRANE RECIEPT

Date:
Project No.:
Project:
Location:
Client:
General Contractors:
Sub-Contractor:

GENERAL INFORMATION

Manufacturer:	*Material Description:*
Weather: *Temperature:*	*Equipment Used to Unload Rolls:*
Roll Certification Received:	*Storage Location of Rolls:*
Comments:	

ROLL INFORMATION

Roll Number	*Roll Identification Number*	*Length (ft.)*	*Width (ft.)*	*Area ($ft.^2$)*

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TRIAL WELD LOG

Date:
Project No.:
Project:
Location:
Client:
Sub-Contractor:

Time	*Operator & Machine No.*	*Fusion Machine Speed/Temp*	*Extrusion Machine Temp/Preheat Temp*	*Test Results (PSI)*					
				Peel (Pass/Fail)	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Shear (Pass/Fail)*

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Internet: www.sitec-engineering.com

PANEL PLACEMENT LOG

Date:
Project No.:
Project: Design
Location:
Client:
Sub-Contractor:

Panel Number	*Roll Number*	*Panel Length (ft.)*	*Panel Width (ft.)*	*Total Area ($ft.^2$)*	*Temporary Loading*	*Overlap*	*Comments*

SITEC

ENVIRONMENTAL

Hazardous & Solid Waste Consultants

Phone: 781-319-0100

Fax: 781-834-4783

Project:
Project Number:
Location:
Client:
General Contractor:
Sub-Contractor:
Product Type:

Primary Geomembrane Seaming & Air Testing Log

Seam Number	Seam Length	Date Seamed	Time	Technician	Mach. Number	Start Time	Start PSI	End Time	End PSI	Pass Fail	Date Tested	Comments

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Phone: (508) 998-2125 ● (781) 319-0100
Fax: (508) 998-7554 ● (781) 834-4783
Internet: www.sitec-engineering.com

DESTRUCTIVE TEST LOG

Date:
Project No.:
Project:
Location:
Client:
Sub-Contractor:

Test No.	*Operator & Machine No.*	*Fusion Machine - Speed/Temp*	*Extrusion Machine Temp/Preheat Temp*	*Test Results (PSI)*					
				Peel (Pass/Fail)	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Peel (Pass/Fail)*	*Shear (Pass/Fail)*

SITEC

ENVIRONMENTAL

Hazardous and Solid Waste Consultants
New Bedford ● Marshfield

Phone: (508) 998-2125 ● (781) 319-0100
Fax: (508) 998-7554 ● (781) 834-4783
Internet: www.sitec-engineering.com

REPAIR LOG

Date:
Project No.:
Project:
Location:
Client:
Sub-Contractor:

Seam No.	*Panel No.*	*Repair No.*	*Description & Location of Repair*	*Repair Vacuum Test Date*	*Pass or Fail*	*Failed Repair Tester & Date*	*Pass or Fail*

SITEC

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New Bedford ● Marshfield

Phone: (508) 998-2125 ● (781) 319-0100
Fax: (508) 998-7554 ● (781) 834-4783
Internet: www.sitec-engineering.com

PANEL SEAMING / SEAM TESTING LOG

Date:
Project No.:
Project:
Location:
Client:
Sub-Contractor:

Seam No.	*Time*	*Seam Length (ft.)*	*Operator & Machine No.*	*Machine Speed/Temp*	*Ambient Temperature (°F)*	*Pressure Test Results*				*Test Date*	*Comments*
						Start		*End*			
						Time	*PSI*	*Time*	*PSI*		